

WHAT IS CLAIMED IS:

1                   1.       A computer-implemented method for use in developing a course of  
2 treatment for an orthodontic patient, the method comprising:  
3                   scanning a patient's teeth or a physical model thereof to obtain data;  
4                   receiving in a computer the data obtained by the scanning;  
5                   obtaining in the computer a digital model of a patient's dentition, including a  
6 dental model representing the patient's teeth at a set of initial positions and a gingival model  
7 representing gum tissue surrounding the teeth; and  
8                   deriving in the computer from the digital model data representing an expected  
9 deformation of the gum tissue as the teeth would move from the initial positions to another  
10 set of positions.

1                   2.       The method of claim 1, wherein the computer derives the expected  
2 deformation of the gum tissue by:  
3                   separating from the gingival model a portion that represents gum tissue  
4 surrounding a particular tooth; and  
5                   subjecting the separated portion to at least one force that is applied to the  
6 particular tooth.

1                   3.       The method of claim 2, wherein the computer reconnects the separated  
2 portion to an adjacent portion of the gingival model after subjecting the separated portion to  
3 the transformation.

1                   4.       The method of claim 3, wherein, in subjecting the separated portion to  
2 at least one force, the computer creates a gap between the separated portion and the adjacent  
3 portion of the gingival model, and, in reconnecting the separated portion to the adjacent  
4 portion, the computer creates a stitching surface to fill the gap.

1                   5.       The method of claim 4, wherein the computer adjusts the shape of the  
2 stitching surface to alter the shape of the gum tissue in the reconnected gingival model.

1                   6.       The method of claim 5, wherein, in adjusting the shape of the stitching  
2 surface, the computer receives instructions from a human operator concerning the shape of  
3 the stitching surface.

1                    7.        The method of claim 4, wherein the stitching surface is bounded by  
2 two curves representing edges of the separated portion and the adjacent portion of the  
3 gingival model.

1                    8.        The method of claim 7, wherein, in creating the stitching surface, the  
2 computer selects points on the curves and connects the points to form triangles representing a  
3 surface mesh.

1                    9.        The method of claim 8, wherein the computer adjusts the shape of the  
2 surface mesh by moving a vertex shared by multiple ones of the triangles along a line.

1                    10.       The method of claim 9, wherein, in moving the vertex, the computer  
2 calculates a normal line for each of the triangles that share the vertex and calculates an  
3 average of the normal lines.

1                    11.       The method of claim 8, wherein the computer divides each of the  
2 triangles into smaller triangles to form a fine surface mesh.

1                    12.       The method of claim 11, wherein the computer divides the triangles  
2 such that each of the smaller triangles has at least one vertex shared by five more of the  
3 smaller triangles.

1                    13.       The method of claim 1, wherein, in deriving an expected deformation  
2 of the gum tissue, the computer selects a point in the gingival model and derives motion of  
3 the point as the teeth move from the initial set of positions to the other set of positions.

1                    14.       The method of claim 13, wherein, in deriving motion of the point, the  
2 computer attaches the point to a model of a corresponding tooth in the dental model and  
3 subjects the point to transformations applied to the corresponding tooth.

1                    15.       The method of claim 13, wherein the point lies on a gingival margin, at  
2 which the gum tissue meets one of the teeth.

1                    16.       The method of claim 13, wherein the computer creates another  
2 gingival model representing the gum tissue surrounding the teeth at the other set of positions.

1                    17.     The method of claim 16, wherein, in creating another gingival model,  
2     the computer selects points in the gingival model, derives positions for the points when the  
3     teeth are at the other set of positions, and creates a curve that connects the points at the  
4     derived positions.

1                    18.     The method of claim 17, wherein, in creating the curve, the computer  
2     selects the curve from a group of curves that have predetermined profiles.

1                    19.     The method of claim 18, wherein, in selecting the curve, the computer  
2     determines which type of tooth is nearest the points in the dentition model and selects a curve  
3     associated with the type of tooth that is nearest the points.

1                    20.     The method of claim 17, wherein, in creating the curve, the computer  
2     interpolates between two curves having predetermined shapes.

1                    21.     The method of claim 17, wherein the computer receives an instruction  
2     from a human operator to modify the shape of the curve.